United States Patent [19]

Groenke et al.

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[45] **Date of Patent: Jul. 1, 1986**

[54] **PLOTTER HAVING AUTOMATIC SHEET FEEDER**

[75] Inventors: **Jeffery W. Groenke; Wallace S. Halliday**, both of San Diego, Calif.

[73] Assignee: **Hewlett-Packard Company**, Palo Alto, Calif.

[21] Appl. No.: **609,065**

[22] Filed: **May 9, 1984**

[51] **Int. Cl.**⁴ **G01D 15/28**

[52] **U.S. Cl.** **346/1.1**; 271/239; 271/250; 271/902; 346/129; 346/134

[58] **Field of Search** .... 346/134, 129, 1.1; 355/14 SH; 271/239, 250, 902

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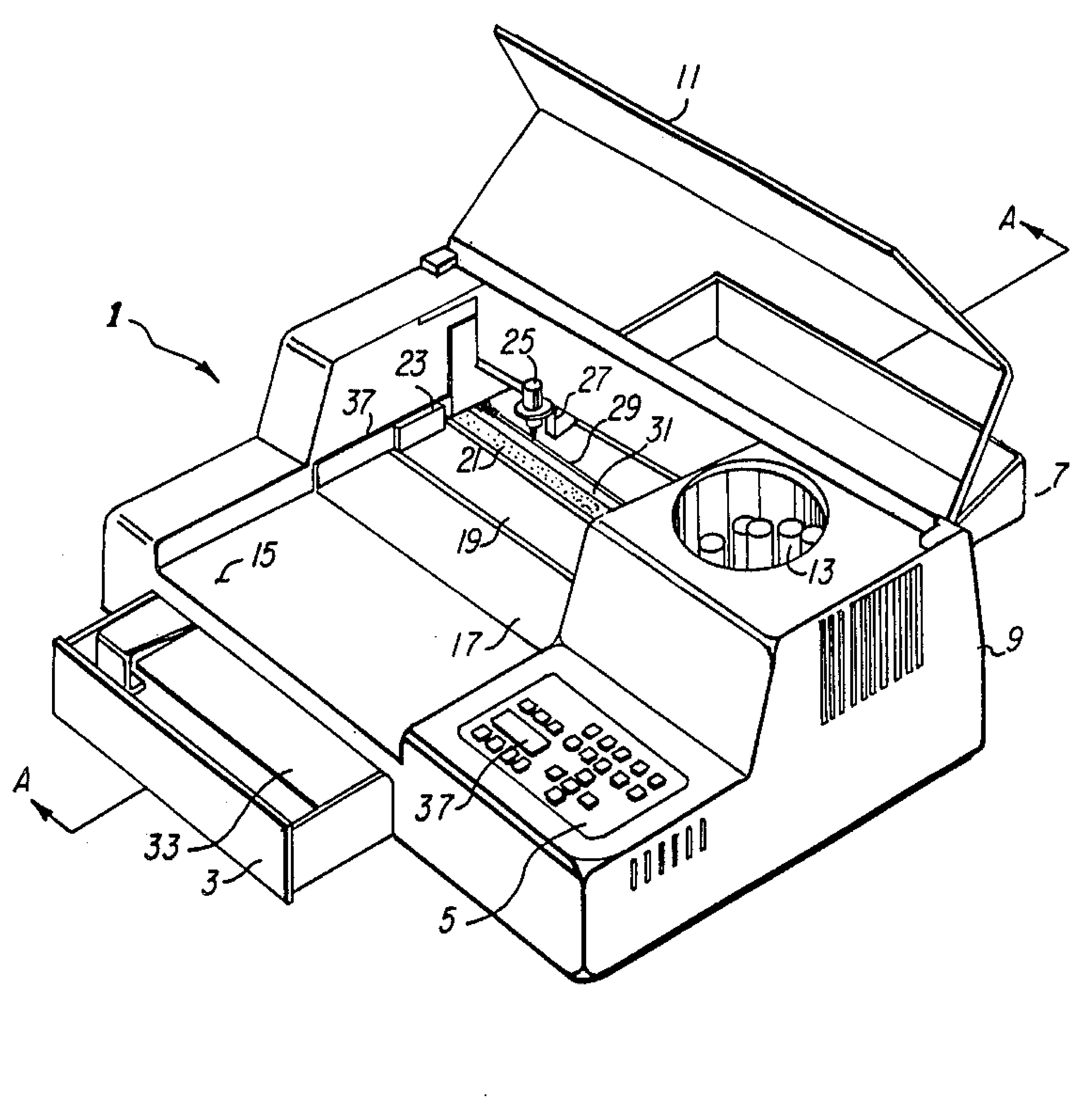
Primary Examiner—Joseph W. Hartary

Attorney, Agent, or Firm—Douglas A. Kundrat; Patrick J. Barrett

[57] **ABSTRACT**

A high accuracy pen plotter includes an automatic sheet feeder for feeding individual sheets of paper from a paper tray to a platen for plotting. A microprocessor, various stepper motors and encoders allow for accurate and repeatable positioning and alignment of the sheet of paper to be plotted. The sheet of paper is automatically fed from the tray to the platen, is pulled entirely free from the tray, is aligned against a reference edge and may be forcefully ejected from the plotter after plotting is finished.

6 Claims, 17 Drawing Figures



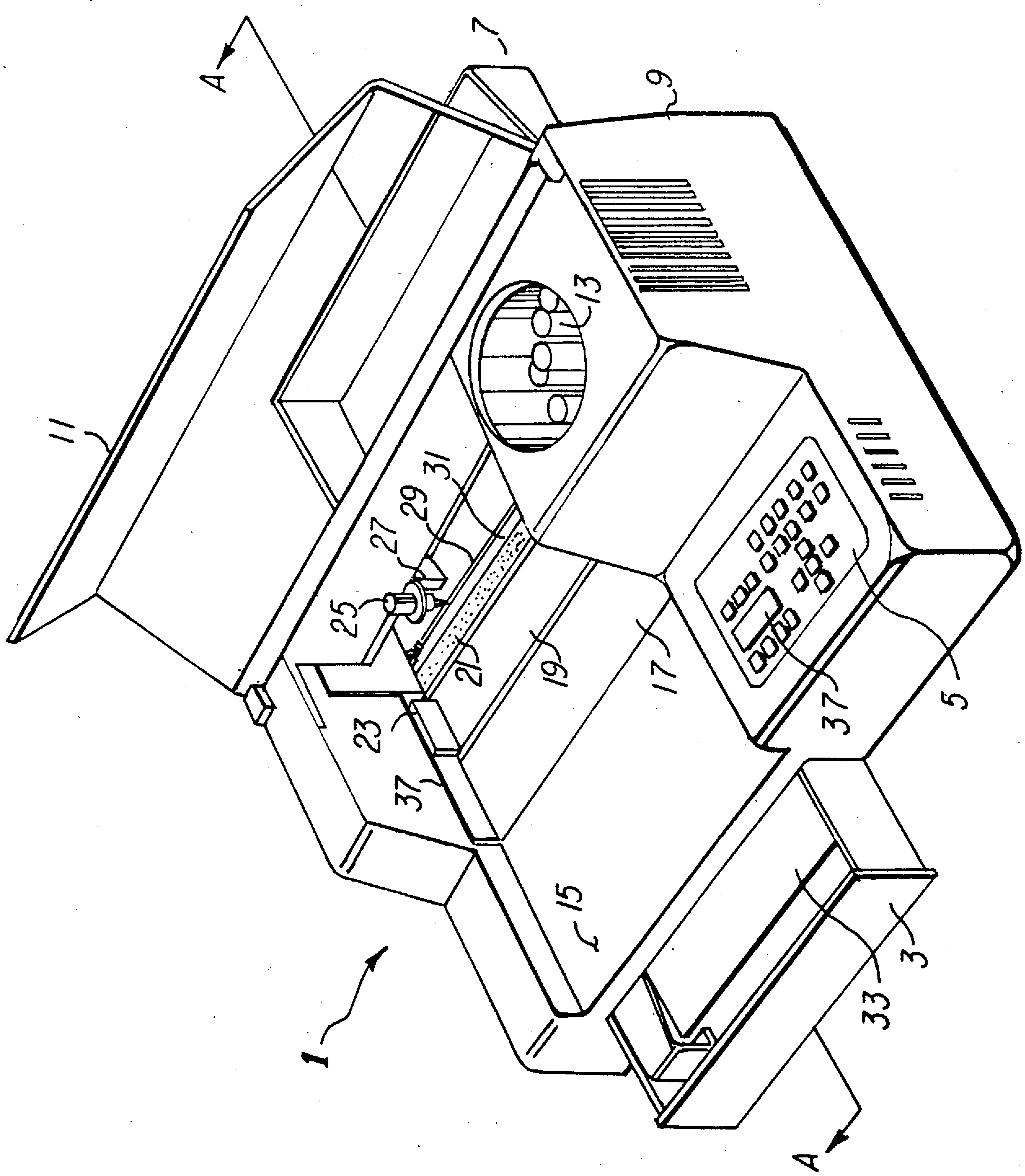


FIG 1

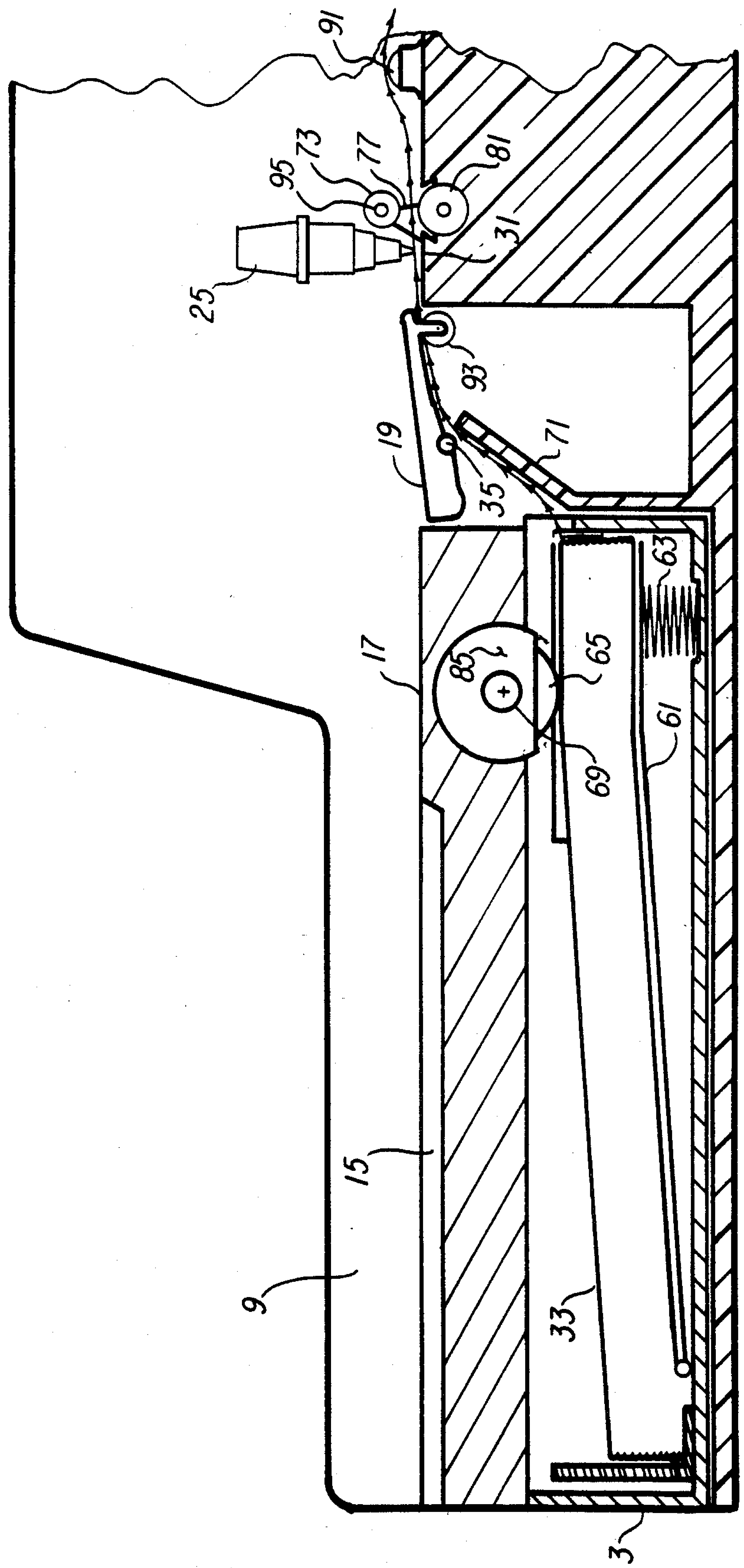


FIG 2

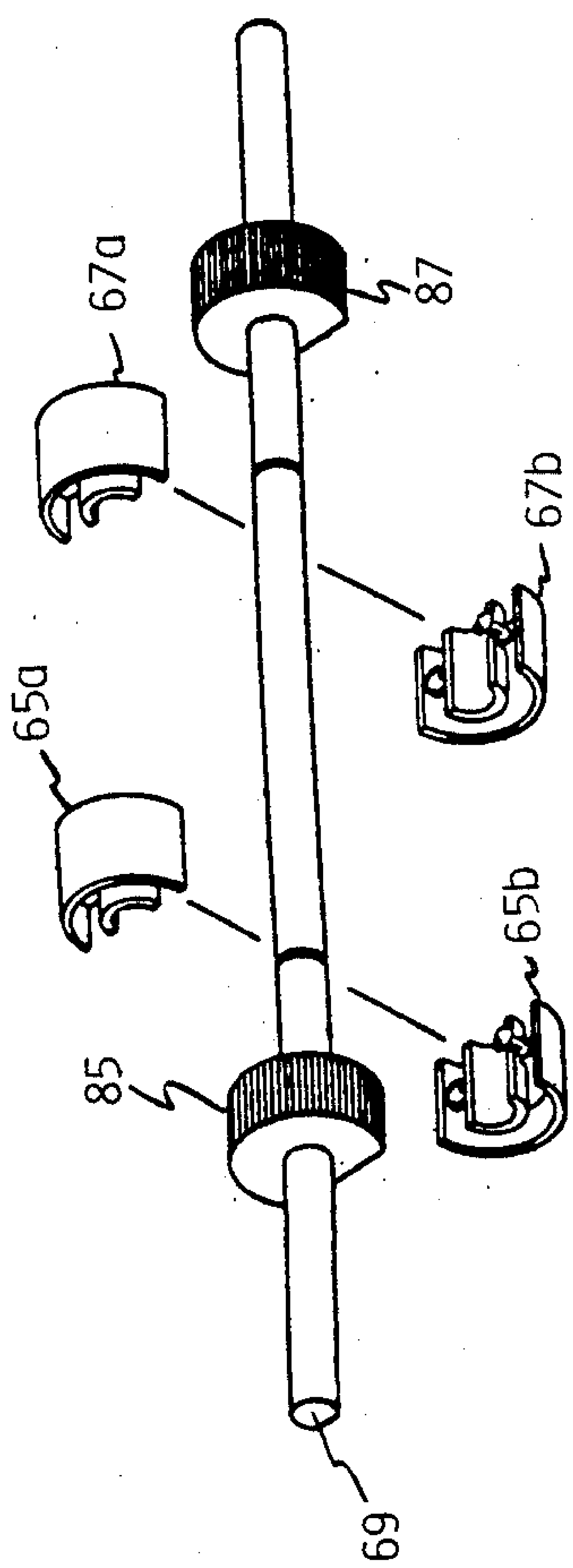


FIG 3

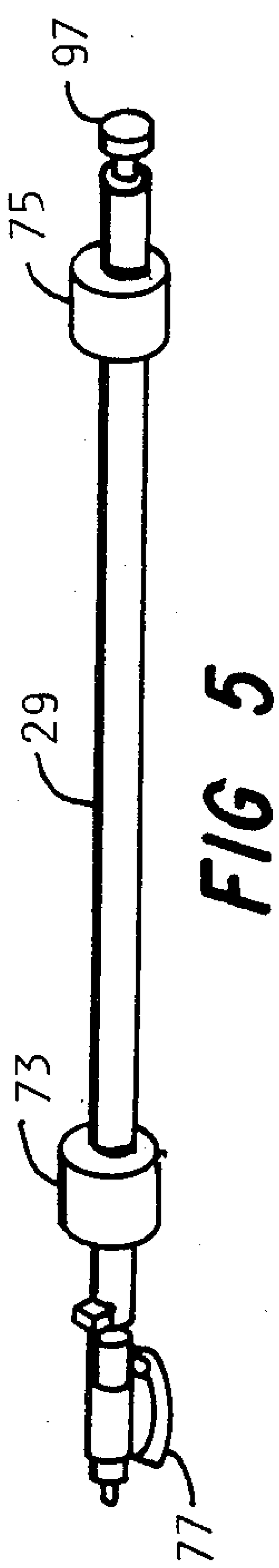


FIG 5

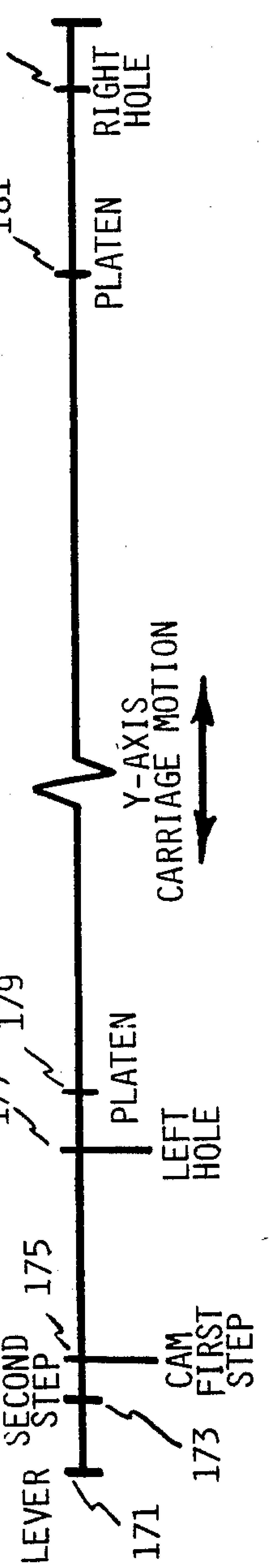


FIG 9

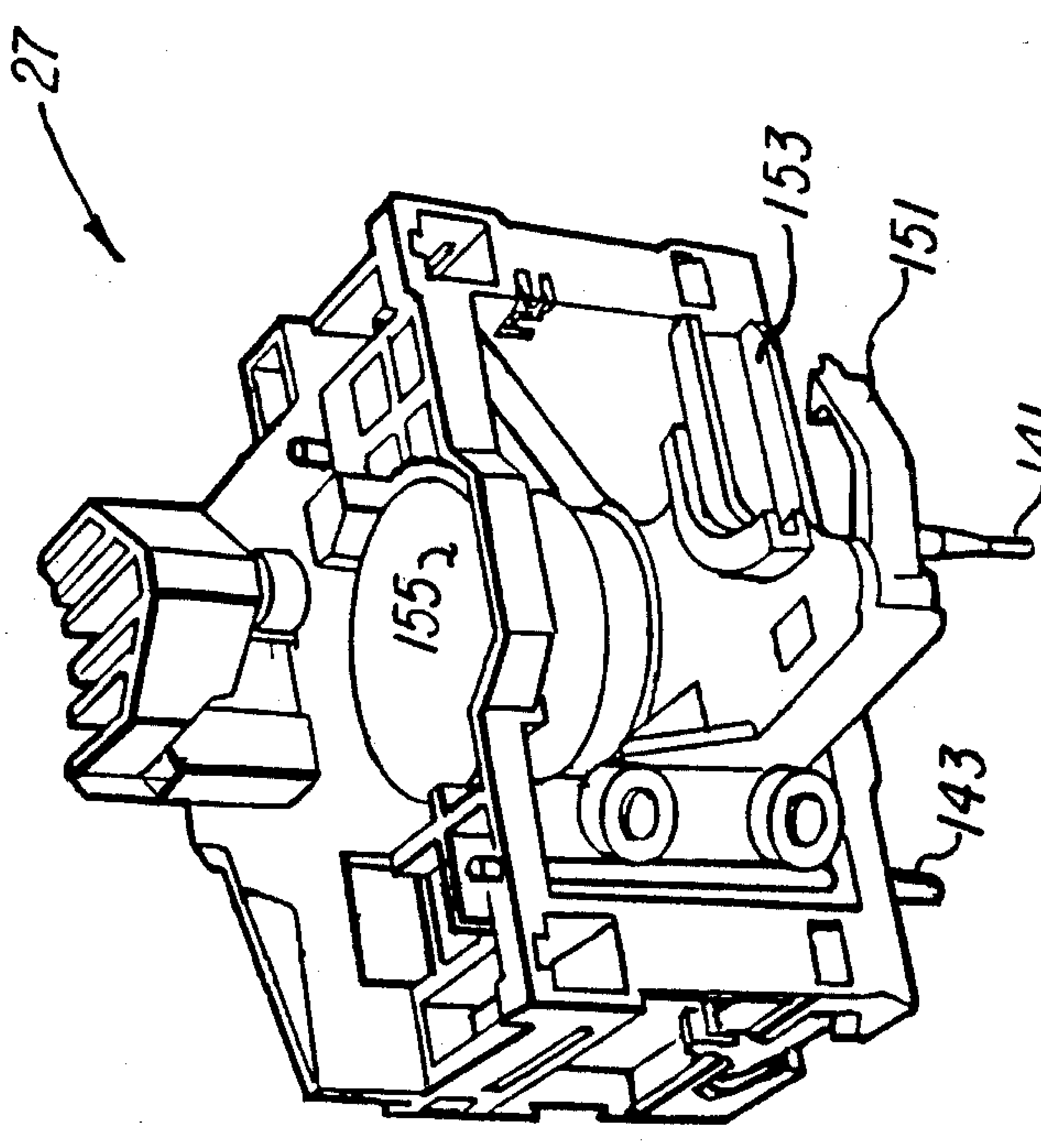


FIG 6

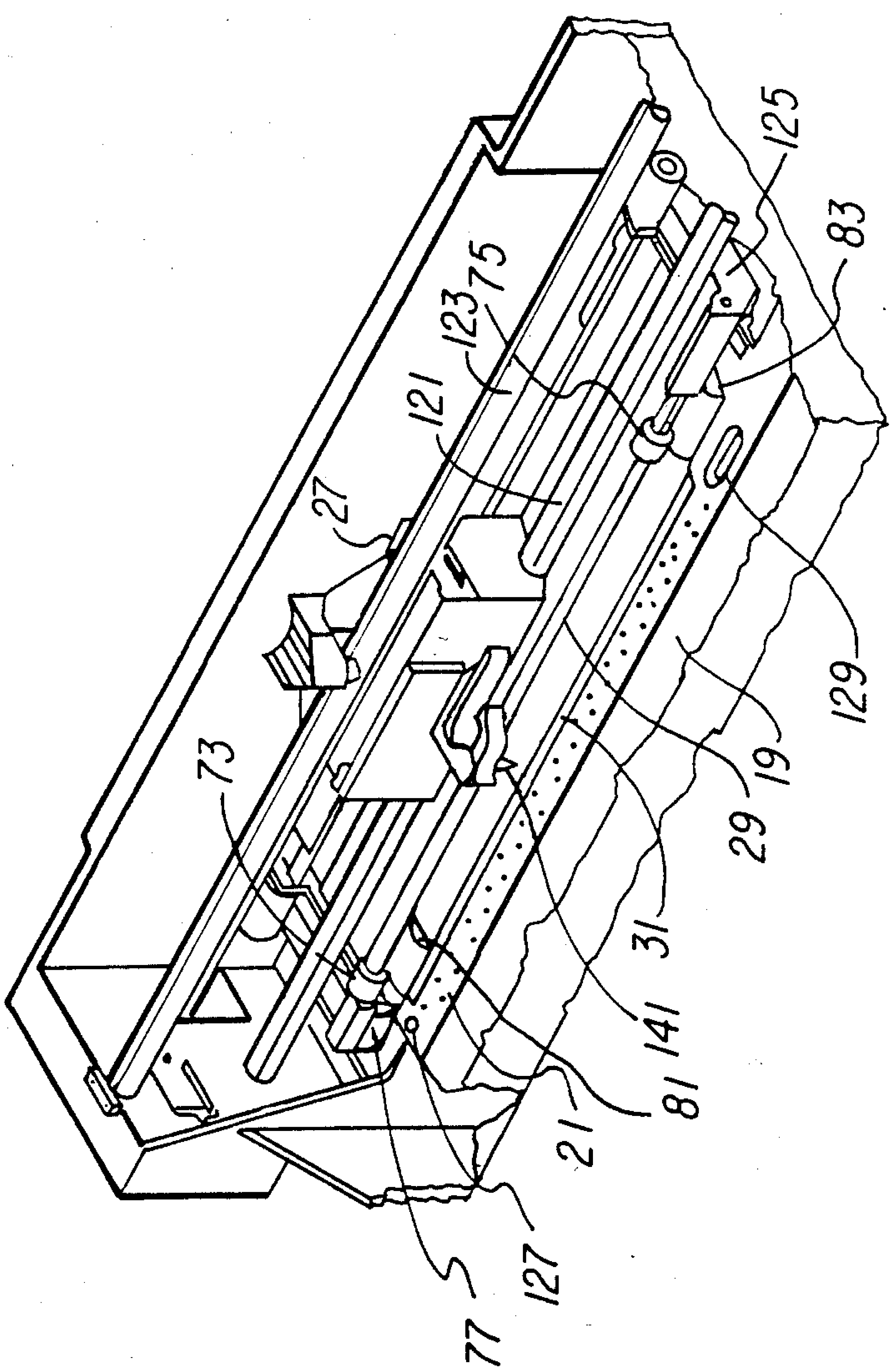


FIG 4

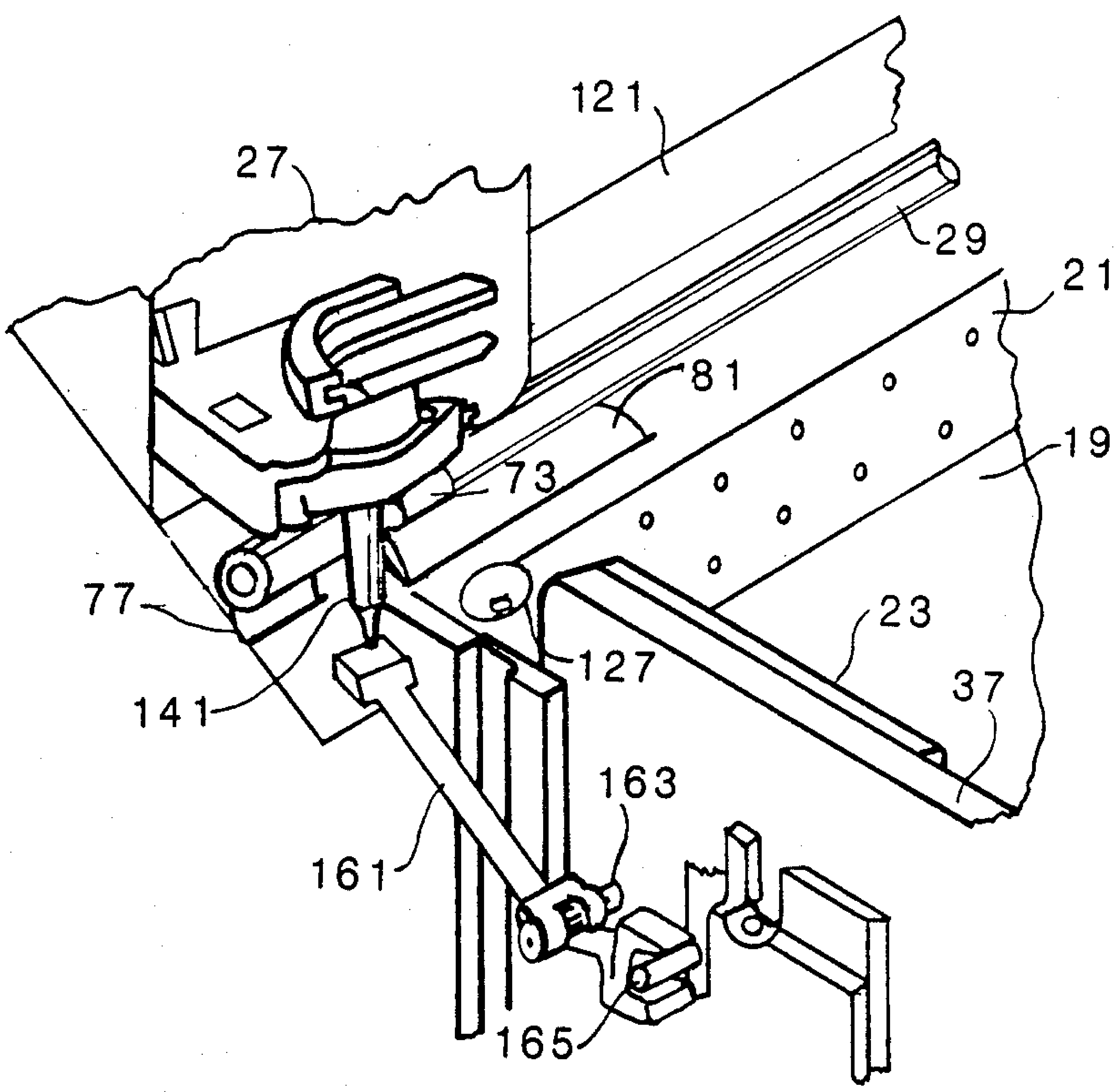


FIG 7

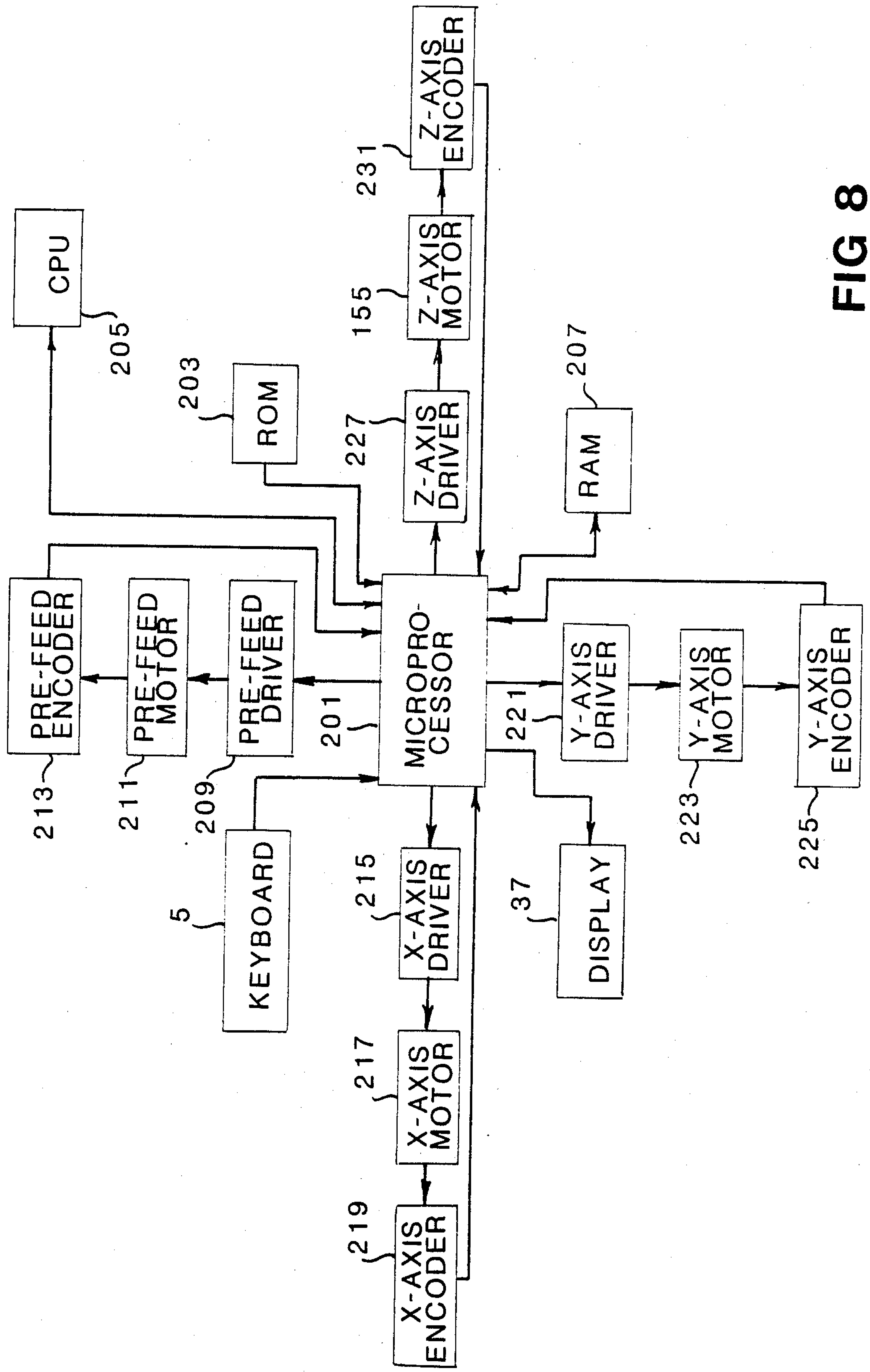

CPU
205
ROM
203
Z-AXIS DRIVER
227
Z-AXIS MOTOR
155
Z-AXIS ENCODER
231
RAM
207
PRE-FEED ENCODER
213
PRE-FEED MOTOR
211
PRE-FEED DRIVER
209
MICROPRO-CESSOR
201
Y-AXIS DRIVER
221
Y-AXIS MOTOR
223
Y-AXIS ENCODER
225
KEYBOARD
5
X-AXIS DRIVER
215
DISPLAY
37
X-AXIS MOTOR
217
X-AXIS ENCODER
219

FIG 8

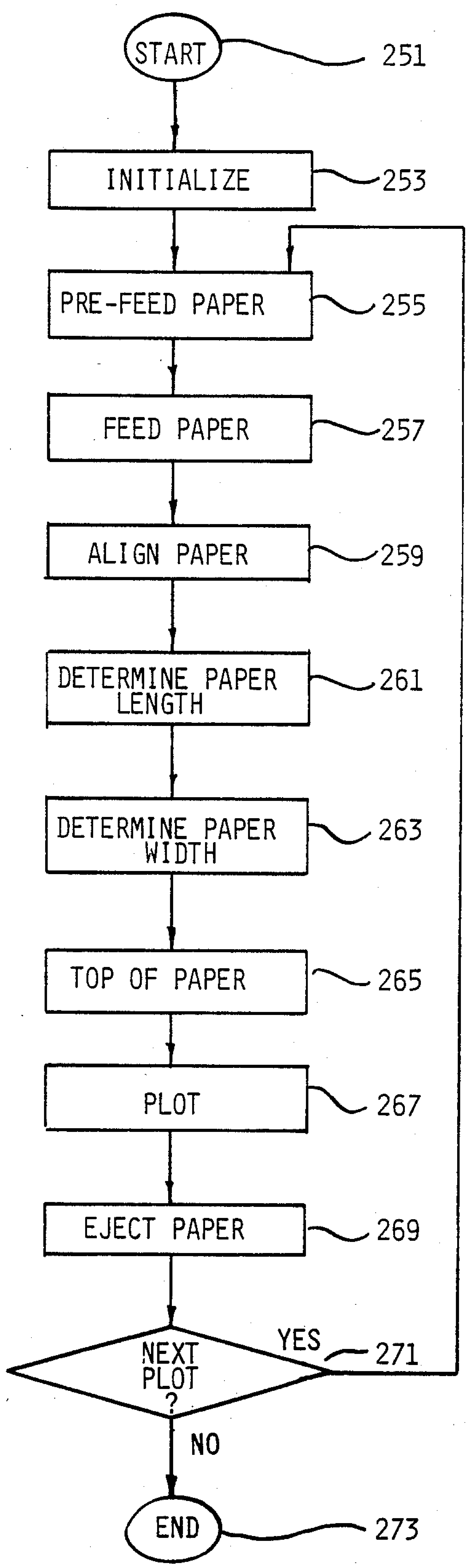

START
251
INITIALIZE
253
PRE-FEED PAPER
255
FEED PAPER
257
ALIGN PAPER
259
DETERMINE PAPER LENGTH
261
DETERMINE PAPER WIDTH
263
TOP OF PAPER
265
PLOT
267
EJECT PAPER
269
NEXT PLOT ?
YES
271
NO
END
273

FIG 10

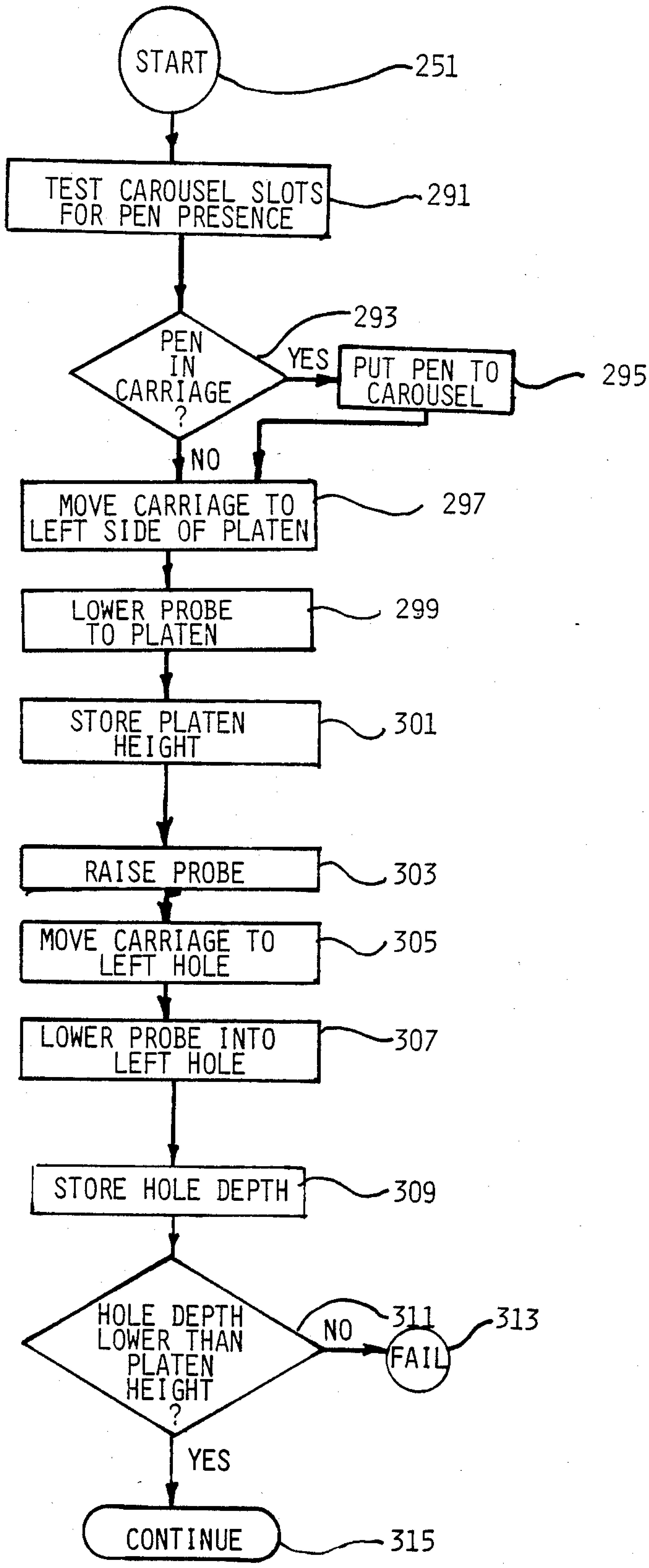

START
251
TEST CAROUSEL SLOTS FOR PEN PRESENCE
291
PEN IN CARRIAGE ?
293
YES
PUT PEN TO CAROUSEL
295
NO
MOVE CARRIAGE TO LEFT SIDE OF PLATEN
297
LOWER PROBE TO PLATEN
299
STORE PLATEN HEIGHT
301
RAISE PROBE
303
MOVE CARRIAGE TO LEFT HOLE
305
LOWER PROBE INTO LEFT HOLE
307
STORE HOLE DEPTH
309
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
311
NO
FAIL
313
YES
CONTINUE
315

FIG 11

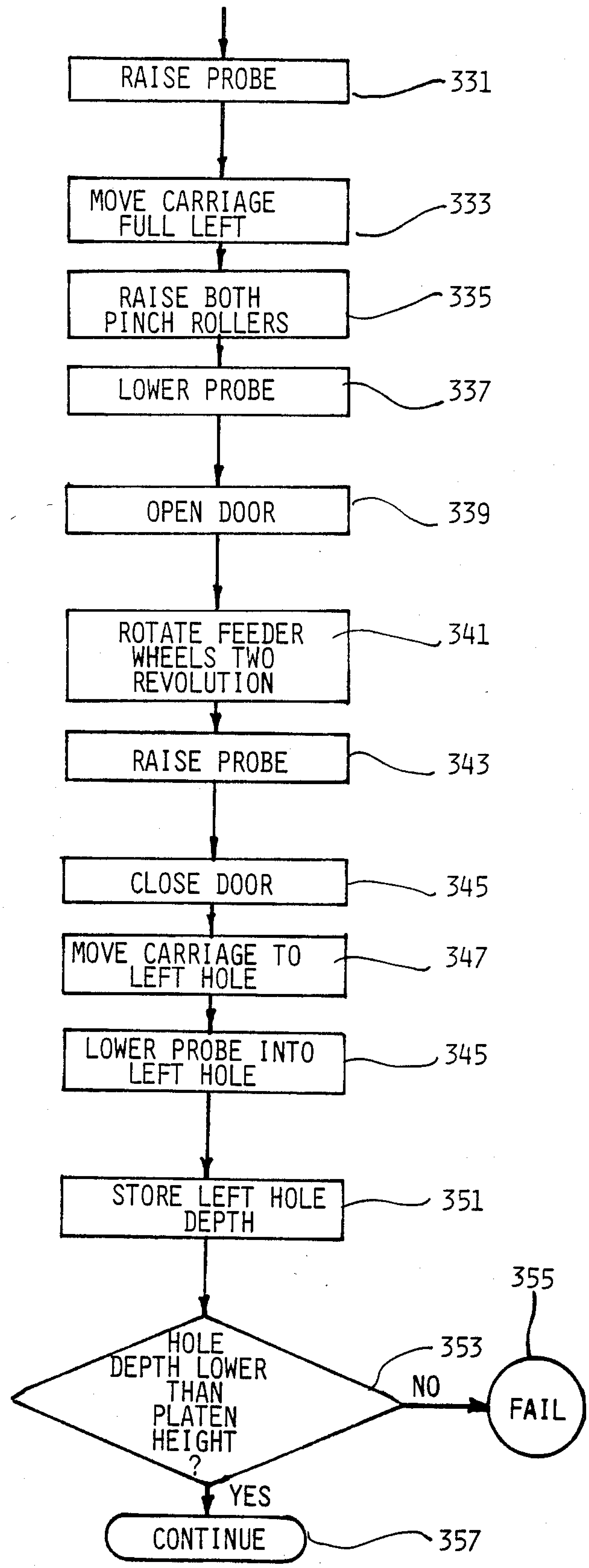

RAISE PROBE
331
MOVE CARRIAGE FULL LEFT
333
RAISE BOTH PINCH ROLLERS
335
LOWER PROBE
337
OPEN DOOR
339
ROTATE FEEDER WHEELS TWO REVOLUTION
341
RAISE PROBE
343
CLOSE DOOR
345
MOVE CARRIAGE TO LEFT HOLE
347
LOWER PROBE INTO LEFT HOLE
345
STORE LEFT HOLE DEPTH
351
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
353
NO
FAIL
355
YES
CONTINUE
357

FIG 12

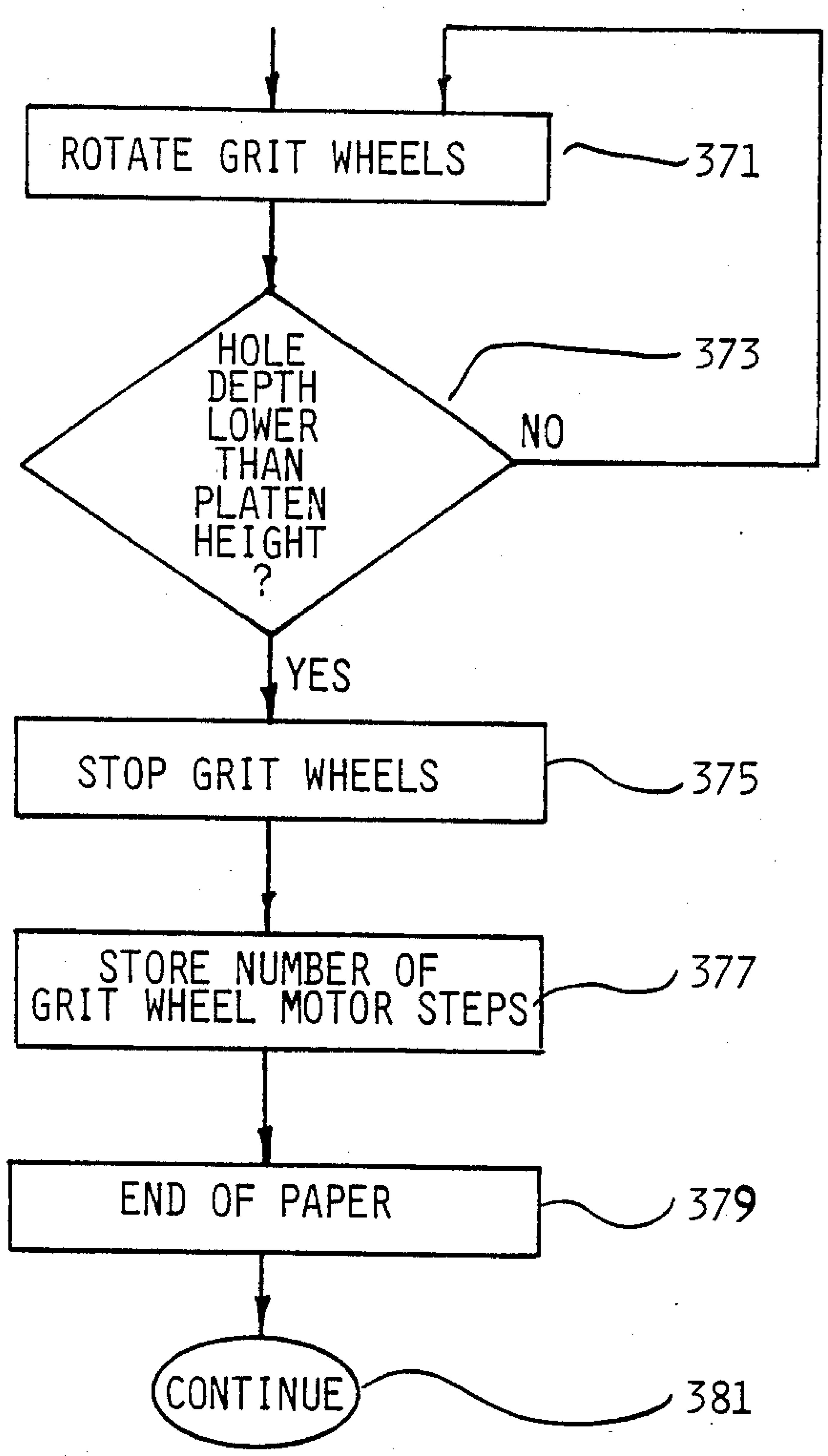
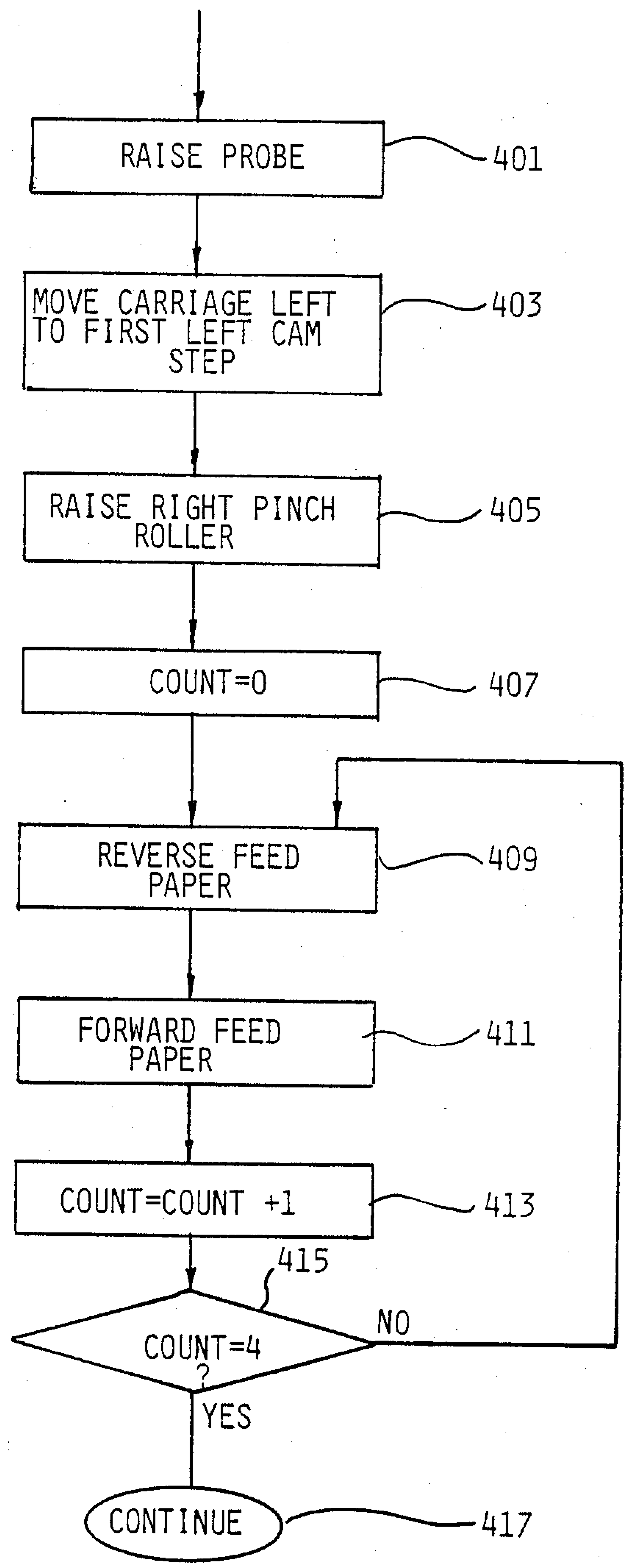

ROTATE GRIT WHEELS
371
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
373
NO
YES
STOP GRIT WHEELS
375
STORE NUMBER OF GRIT WHEEL MOTOR STEPS
377
END OF PAPER
379
CONTINUE
381

FIG 13



RAISE PROBE
401
MOVE CARRIAGE LEFT TO FIRST LEFT CAM STEP
403
RAISE RIGHT PINCH ROLLER
405
COUNT=0
407
REVERSE FEED PAPER
409
FORWARD FEED PAPER
411
COUNT=COUNT +1
413
415
COUNT=4 ?
NO
YES
CONTINUE
417

FIG 14

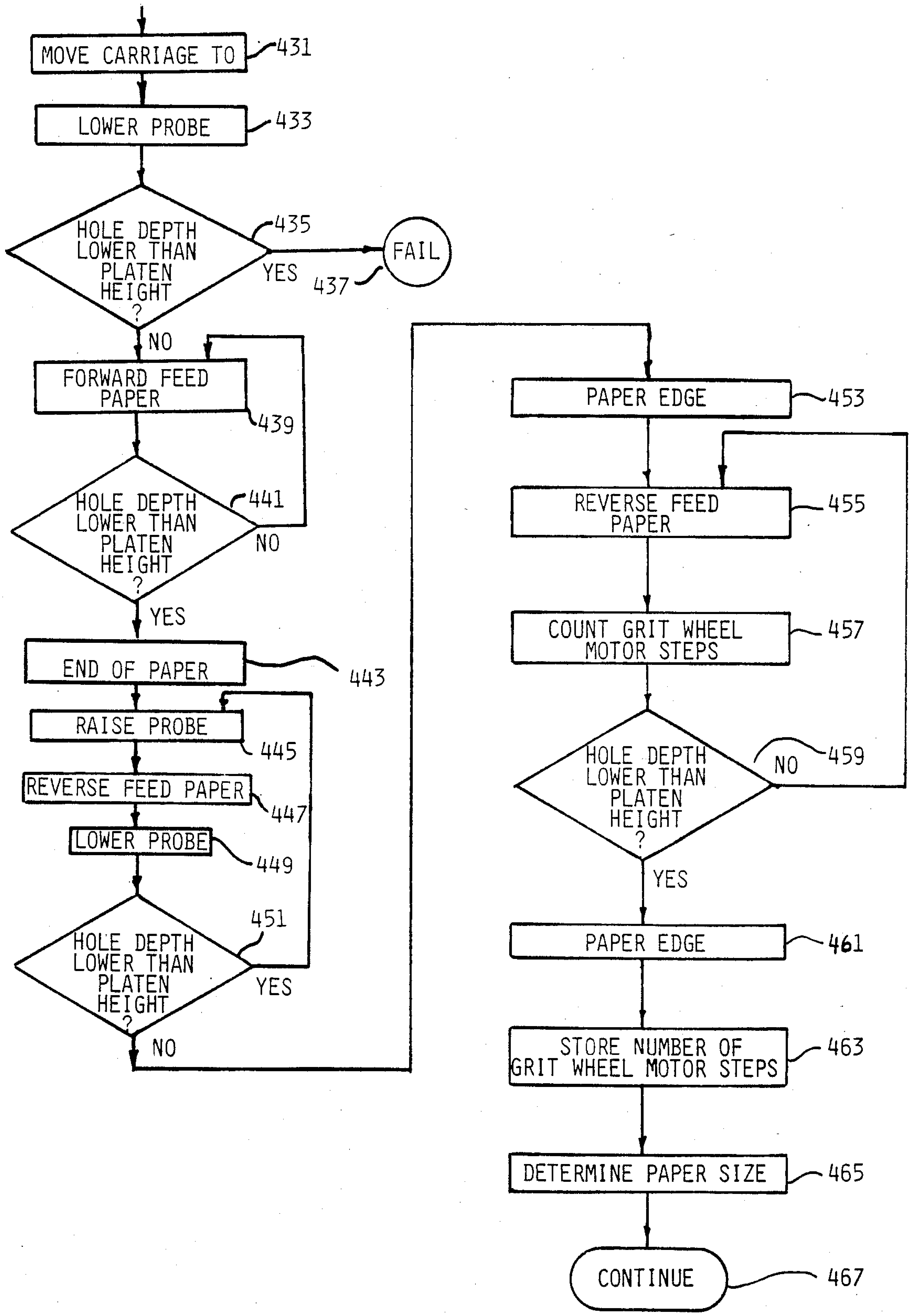

MOVE CARRIAGE TO
431
LOWER PROBE
433
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
435
YES
FAIL
437
NO
FORWARD FEED PAPER
439
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
441
NO
YES
END OF PAPER
443
RAISE PROBE
445
REVERSE FEED PAPER
447
LOWER PROBE
449
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
451
YES
NO
PAPER EDGE
453
REVERSE FEED PAPER
455
COUNT GRIT WHEEL MOTOR STEPS
457
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
NO
459
YES
PAPER EDGE
461
STORE NUMBER OF GRIT WHEEL MOTOR STEPS
463
DETERMINE PAPER SIZE
465
CONTINUE
467

FIG 15

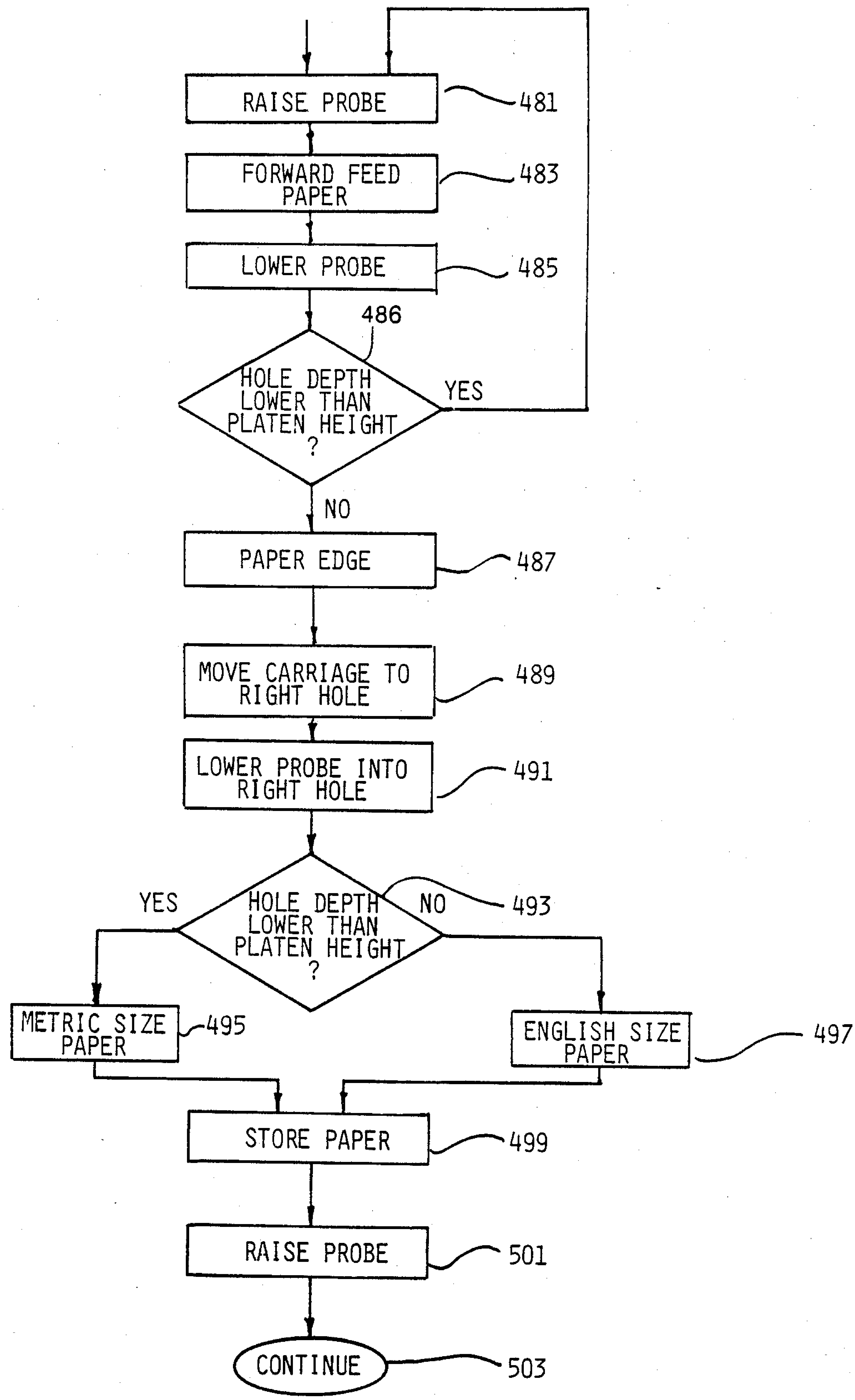

RAISE PROBE
481
FORWARD FEED PAPER
483
LOWER PROBE
485
486
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
YES
NO
PAPER EDGE
487
MOVE CARRIAGE TO RIGHT HOLE
489
LOWER PROBE INTO RIGHT HOLE
491
HOLE DEPTH LOWER THAN PLATEN HEIGHT ?
YES
NO
493
METRIC SIZE PAPER
495
ENGLISH SIZE PAPER
497
STORE PAPER
499
RAISE PROBE
501
CONTINUE
503

FIG 16

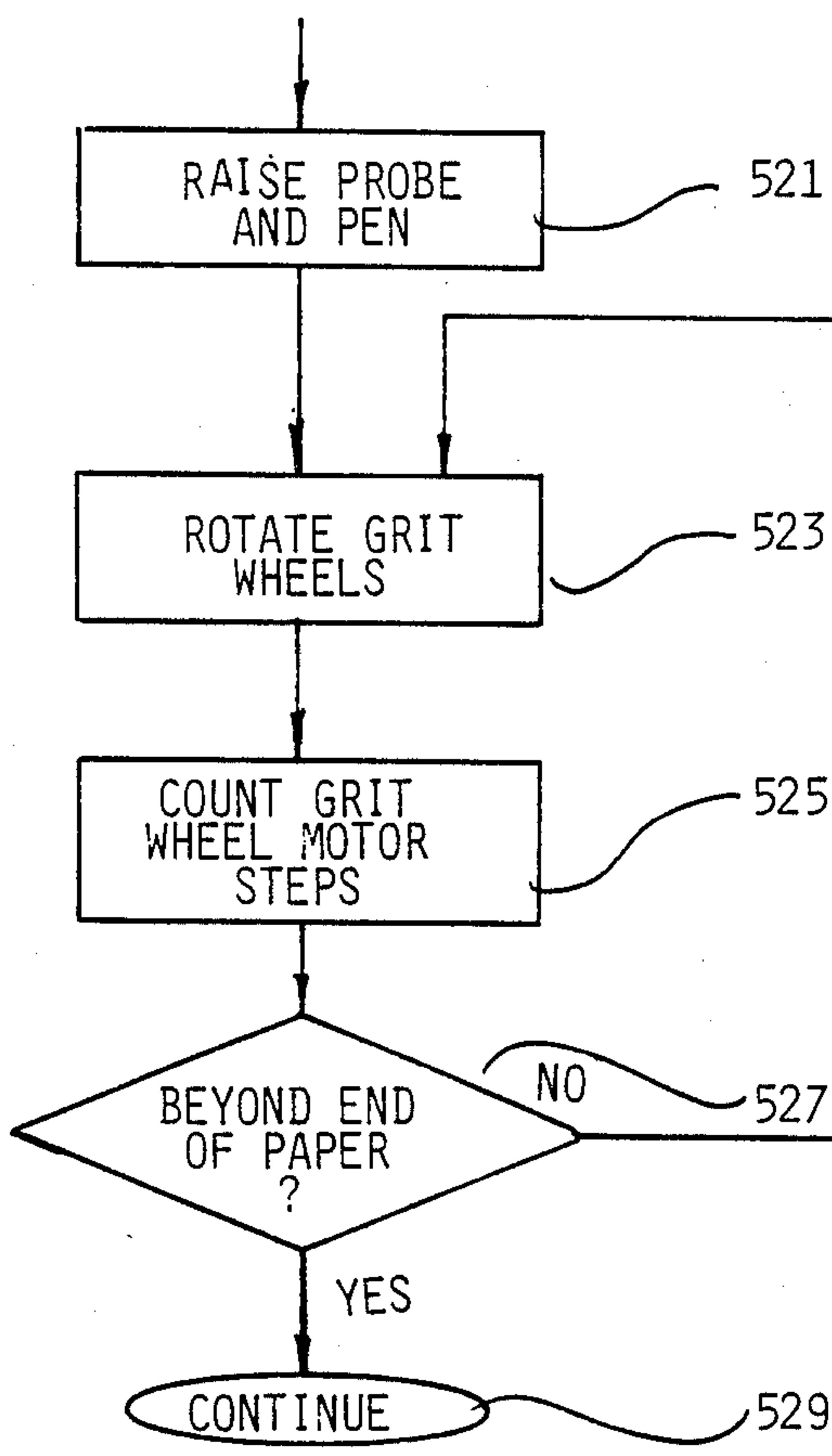

RAISE PROBE AND PEN
521
ROTATE GRIT WHEELS
523
COUNT GRIT WHEEL MOTOR STEPS
525
BEYOND END OF PAPER ?
NO
527
YES
CONTINUE
529

FIG 17

PLOTTER HAVING AUTOMATIC SHEET FEEDER

BACKGROUND AND SUMMARY OF THE INVENTION

With the advent of low-cost microprocessors, high speed and high resolution pen plotters have become increasingly sophisticated. Most plotters, such as the Hewlett-Packard Co. model 7470A plotter, require that the operator manually load and orient each sheet of paper prior to plotting. This requirement drastically decreases plotter throughput and also increases plotting costs because of the need for operator supervision. A number of plotters, such as the Hewlett-Packard Co. model 7586B plotter, allow roll feeding using a continuous paper roll from which individual sheets are cut to size after plotting is completed. Although roll feeding increases speed and reduces cost, it requires the use of special roll paper which is often disadvantageous in addition to being costly.

In accordance with the illustrated preferred embodiment of the present invention, a microprocessor controlled plotter incorporates an automatic sheet feeder which provides feeding and alignment of individual sheets of paper. The plotter is capable of high speed plotting without operator supervision and allows for the use of low cost and commonly available sheet paper. By the use of stepper motors and linear and angle encoders, paper motion can be monitored with a high degree of accuracy and highly accurate positioning and alignment of the paper can be obtained. Although commonly available photocopiers use various techniques for sheet feeding of copier paper, none of the photocopiers achieves, or requires, the high degree of positioning and alignment accuracy that is achieved by the present invention.

Paper is received from a paper tray by the use of the forward buckling feed technique which is commonly used in low cost photocopiers such as the Canon, Inc., model PC-20 copier. In this pre-feed step, the paper is fed through a deflection door and the leading edge is set between a pair of grit wheels and a pair of pinch rollers. A pen carriage includes a probe which is used to detect paper presence at the platen and which is also used to open and close the deflection door. Once a pre-feed step is successfully completed and paper is detected at the platen, the door is lightly closed and the grit wheels pull the sheet of paper onto the platen until the trailing edge is detected. The paper edge is aligned with an edge perpendicular to pen carriage motion by releasing one grit wheel and forward and reverse feeding the paper a number of times. Rotational forces about the fixed grit wheel cause the paper edge to firmly align against the perpendicular edge.

With the use of high accuracy stepper motors and encoders, the length and width of the aligned paper is determined to a high degree of accuracy and this information may be used by the microprocessor to control subsequent plotting. When plotting is completed, the grit wheels are used to eject the sheet of paper and a new sheet may be fed and aligned on the platen.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a plotter which is constructed in accordance with the preferred embodiment of the present invention.

FIG. 2 shows a cut-away view, along line A—A, of the plotter shown in FIG. 1.

FIG. 3 shows a detail view of a component of the plotter shown in FIG. 1.

FIG. 4 shows a detailed view of a portion of the plotter shown in FIG. 1.

FIG. 5 shows a detail view of a component of the plotter shown in FIG. 1.

FIG. 6 shows a detail view of the pen carriage used in the plotter shown in FIG. 1.

FIG. 7 shows a detail view of a portion of the plotter shown in FIG. 1.

FIG. 8 is a block diagram of the plotter shown in FIG. 1.

FIG. 9 shows various positions in the Y-axis travel of the pen carriage used in the plotter shown in FIG. 1.

FIG. 10 is a flow chart of the automatic sheet feed and alignment procedures performed by the plotter shown in FIG. 1.

FIGS. 11–17 are detailed flow charts which set out the individual steps performed by the plotter shown in FIG. 1 during performance of the steps shown in the flow chart of FIG. 10.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 shows a plotter 1 which is constructed in accordance with the illustrated preferred embodiment of the present invention. A paper tray 3, similar to those used in low cost photocopiers such as the Canon, Inc., model PC-20, allows for the use of both metric and English size paper 33. A keyboard 5 allows the user to input specific commands to the plotter 1 and a display 37 allows certain responses to be given to the user. Control of the plotter 1 may also be performed by use of an independent computer. A receiving tray 7 is used to catch completed plots on sheets of paper. A housing 9 and a clear cover 11 protect the mechanisms of the plotter 1. A pen carousel 13, similar to those used in, .e.g., the Hewlett-Packard Co. model 7580B plotter, allows for the use of eight different pens 25 during plotting. Beds 15 and 17 support the paper during sheet feeding, alignment and plotting. Deflection door 19 also serves to support the paper and allows for feeding of the paper from the paper tray 3.

Platen 21 supports the paper during plotting by pen 25 over a writing surface 31 portion of the platen 21. Platen 21 may include air holes which allow a vacuum to be applied to the paper to firmly hold the paper in place during plotting. All of the flat surfaces which contact the paper may be fabricated from plastic, but it is preferable to use a plastic compound which includes carbon so as to be electrically conductive. In this way, the flat surfaces may be grounded and increased friction due to static electricity may be avoided. A perpendicular edge 37, orthogonal to the travel of pen 25, allows for accurate alignment of the paper before plotting. A small gap exists between door 19 and a hold-down 23 to force paper fed through the gap into close proximity with the platen 21. A pen carriage 27 moves the pen 25 as directed by the microprocessor and also permits paper detection and measurement as is hereinbelow discussed.

FIG. 2 shows a cut-away schematic view of plotter 1 along lines A—A in FIG. 1. The feed path of a sheet of paper 33 is shown by an arrowed line. The paper 33 is loaded against a free idler wheel idler 65 by a spring 63 and a base 61 at the insertion of paper tray 3. A serrated rubber drive wheel **85**, mounted on a common drive shaft **69**, is flatted to avoid contact with paper **33** until desired. The details of idlers **65, 67** and drive wheels **85** and **87** may be seen in FIG. **3**. When feeding of a sheet of paper **33** is desired, shaft **69** is rotated two times which causes the top sheet of paper **33** to be driven along the paper path. This pre-feed step utilizes the well-known forward-buckling technique of paper loading. The rounded distance along the surface of wheel **85** is chosen so that two revolutions position the leading edge of the sheet of paper between pinch roller **73** and grit wheel **81**.

With the use of a stepper motor **211** and a shaft angle encoder **213** under control of a microprocessor **201**, as shown in FIG. **8**, extremely precise control of paper location is achieved since resolution on the order of 0.001 inch is achievable using readily available devices. The sheet of paper **33** is deflected by wall **71** and fits under deflection door **19** which is hinged at pin **35** and is opened as is discussed below. Rollers **91** and **93** allow for smooth motion of the paper **33** between writing surface **31** and pen **25**. Pinch roller **73**, on pinch roller shaft **95**, is lifted away from grit wheel **81** by the use of a cam **77** as is discussed below to allow easy passage of the paper **33**. A detailed view of shaft **29**, pinch rollers **73, 75**, right cam **97** and left cam **77** is shown in FIG. **5**. It should be noted that cam **77** is a two-step, helical cam which allows for staged rotational motion of shaft **29**.

FIG. **4** shows a detailed view of the region of plotter **1** adjacent to, and posterior to, the pen carriage **27** with the pen **25** removed for clarity. Carriage **27**, riding on support shafts **121** and **123**, traverses left and right (Y-axis) under the control of the microprocessor **201** using driver **221**, stepper motor **223** and shaft angle encoder **225** shown in FIG. **8**. By virtue of the high resolution available using modern devices, high and repeatable accuracy in the placement of the pen carriage **27** and the pen **25** in the Y-axis is possible. The pen carriage **27** is shown in more detail in FIG. **6** and includes a backing **153** and a clamp **151** for firmly holding the pen **25**. Details of the clamping operation of the pen carriage **27** may be found in U.S. patent application Ser. No. 352,405, which was filed by David C. Tribolet and David L. Paulsen on Feb. 25, 1982, and which is incorporated herein by reference. A voice coil **155** is used to move the pen **25** and a probe **141** in the Z-axis under control of the microprocessor **201** as shown in FIG. **8**. A linear encoder **231** (not shown in FIG. **4**) is also mounted on carriage **27** to monitor motion in the Z-axis. A pin **143**, protruding from the base of carriage **27**, is operative for slidably engaging helical cam **77** as carriage **27** is moved to the left.

The Y-axis motion of carriage **27** may be seen in FIG. **4**. Carriage **27** is moved by motor **223** using a well-known flexible drive belt which is not shown in FIG. **4** for the sake of clarity. If carriage **27** is moved to the right towards pinch roller **75** and grit wheel **83**, probe **141** may be positioned over a hole **129** which is located in platen **21**. If carriage **27** is moved to the left towards pinch roller **73** and grit wheel **81**, probe **141** may be positioned over a left hole **127**. If carriage **27** is moved further to the left, pin **143** contacts the first step of cam **77** and causes the right pinch roller **75** to pivot with arm **125** and to lift above the right grit wheel **83**. If carriage **27** is moved further to the left, pin **143** engages the second step of cam **77** and causes the left pinch roller **73** to lift above the left grit wheel **81** so that neither grit wheel is in contact with a pinch roller and the paper **33** may freely pass thereby.

If the carriage **27** is moved as far as possible to the left, as shown in FIG. **7**, probe **141** is positioned above a lever **161** as pin **143** remains on the second step of cam **77** so that both pinch rollers remain lifted. If probe **141** is lowered by actuation of motor **155**, lever **161** is pivoted about post **163** and stud **165** of door **19** is elevated causing door **19** to open to the position shown in FIG. **2**.

FIG. **9** shows the various positions of carriage **27** as motion in the Y-axis is made. At position **171**, probe **141** is in position to cause door **19** to open and pin **143** is engaged with the second step of cam **77**. At position **173**, pin **143** is still engaged with the second step of cam **77**, but probe **141** is not positioned over lever **161**. At position **175**, pin **143** is engaged with only the first step of cam **77**. At position **177**, probe **141** is positioned over the left hole **127**. At positions **179** and **181**, probe **141** is positioned over platen **21**. Finally, at position **183**, probe **141** is positioned over right hole **129**.

FIG. **10** is a flow chart of the operations performed by the plotter **1** during the plotting of a sheet of paper **33**. Plotting may be made under control of an external computer or CPU **205** and may be aided by the user through keyboard **5**. ROM **203** contains many of the routines performed by plotter **1** during plotting. The initialization step **253** is shown in greater detail in the flow chart of FIG. **11**. In steps **291–293**, an initial test for the location of pen **25** is performed as is described in more detail in the above-referenced Tribolet and Paulsen U.S. patent application. In steps **297** and **299**, the carriage **27** is moved to the position **179** and in steps **301, 303**, the probe **141** is lowered and the distance to the platen **21** is stored in RAM **207** by recording the motion detected by the linear encoder **231**. In steps **305–309**, the carriage **27** is moved to position **177** and an attempt is made to lower probe **141** into hole **127**. If the probe **141** is able to move lower than the previously measured platen **21** level, then it is assumed that no paper is present on the platen **21**. Conversely, if probe **141** is unable to move below the level of platen **21**, it is assumed that a sheet of paper is on platen **21** blocking the probe **141** and a failure condition is encountered. At this point, the user may request ejection of the paper or other failure resolution routines may be performed.

The next step **255** is to pre-feed a sheet of paper **33** from the paper tray so that the leading edge may be gripped by the grit wheels **81, 83**. Step **255** is shown in greater detail in the flow chart of FIG. **12**. In steps **331–339**, the carriage **27** is moved to position **171** and probe **141** is lowered so that deflection door **19** is opened to allow motion thereby of a sheet of paper **33**. In step **341**, microprocessor **201** causes the pre-feed motor **211**, monitored by shaft angle encoder **213**, to rotate the shaft **69** exactly twice. This causes the sheet of paper **33** to follow the paper path shown in FIG. **2** so that the leading edge reaches the grit wheels **81, 83**. In steps **343, 345**, the probe **141** is raised causing the door **19** to close and to rest lightly upon the sheet of paper **33**. In steps **347–353**, the carriage **27** is moved to position **177** and the probe **141** is lowered to determine if the sheet of paper **33** is resident on the platen **21**. If not, a failure of paper pre-feed is determined to have occurred and a failure routine must be performed.

The next step **257** is performed if a successful pre-feed has occurred. FIG. **13** shows the feed paper step **257** in greater detail. In steps **371, 373**, grit wheels **81, 83** (gripping the sheet of paper 33 against pinch rollers 73, 75) are controlled by microprocessor 201 and motor 217 to pull the sheet of paper completely onto the platen 21. The shaft angle encoder 219 monitors the total travel of the sheet of paper 33 to obtain a rough estimate of its length (possibly in error due to misalignment). When the probe 141 falls below the platen 21 level, indicating that the trailing edge of paper 33 has passed, microprocessor 201 causes the motor 217 to stop rotation of the grit wheels 81, 83. The total travel monitored by encoder 219 is stored in RAM 207 for future reference.

In step 259, the sheet of paper 33 is aligned so that high accuracy plotting may take place. FIG. 14 shows the alignment step 259 in greater detail. At this point, the sheet of paper 33 is beneath the carriage 27 and beyond the probe 141 which is still lowered within hole 127. In steps 401–405, the carriage 27 is moved to position 175 so that pin 143 engages the first step of cam 77 and the right pinch roller 75 is raised above the right grit wheel 83. Thus, the sheet of paper 33 is gripped only by the force of pinch roller 73 against grit wheel 81. The sheet of paper 33 is then, in steps 407–415, fed back and forth a number of times. Investigation has indicated that a total of four passes creates accurate alignment with a minimum of delay. Microprocessor 201 monitors the travel of paper 33 using encoder 219 and the previously measured length stored in RAM 207 to ensure that contact with grit wheel 81 is not inadvertently lost. The rotational force around grit wheel 81 causes the sheet of paper 33 to align against edge 37 so that the leading edge of paper 33 is parallel to the Y-axis travel of pen 25. Thus, highly accurate alignment of paper 33 is achieved and highly accurate and highly repeatable plotting may be performed. It is important that the speed and the acceleration of the back and forth travel of the paper 33 not be so high as to buckle or damage the paper 33. In addition, the coefficient of friction between the paper 33 and the various surfaces of plotter 1 must not be so high as to cause buckling of the paper 33 against the perpendicular edge 37 as the paper 33 is moved back and forth.

In step 261, the length of the sheet of paper 33 is determined. FIG. 15 shows the step 261 in greater detail. In steps 431–437, the carriage 27 is moved to position 177 and a determination of the presence of the paper 33 on the platen 21 is made. If the paper 33 is not detected, a failure routine must be implemented since the paper 33 has inadvertently been ejected beyond the grit wheel 81 and paper drive is no longer possible. In steps 439–443, the paper 33 is fed forward until the trailing edge is detected by probe 141. In steps 445–453, the probe 141 is placed just on the trailing edge of the paper 33. Then, in steps 455–461, the paper 33 is reverse fed by grit wheels 81, 83 until the leading edge is detected by probe 141. In step 463, the count of encoder 219 is stored in RAM 207 and in step 365, microprocessor 201 may determine the length of the paper 33 therefrom for future use.

In step 263, the width of the paper 33 is determined for future reference. FIG. 16 shows the steps of step 263 in greater detail. In steps 481–487, the probe 141 is lowered just onto the leading edge of the paper 33. In steps 489–493, the carriage 27 is then moved to position 183 and a determination of the presence of the right edge of the paper 33 is made. If the right hole 129 is made a correct distance from the edge 37, then presence or non-presence of the right edge of the paper 33 indicates English or metric sizing of the paper 33 as depicted in steps 495 and 497. Alternatively, right hole 129 may be fabricated as a slot and probe 141 may be slid from left to right across the paper 33 until it falls off of the paper 33 into the slotted hole 129 to indicate the right edge. Encoder 219 may be used to monitor the distance travelled from a known point such as the left hole 127 to the right edge and the distance from the edge 37 to the known point may be stored in ROM 203 so that microprocessor 201 may compute the exact width of the paper 33 if desired. In step 499, the size of the paper 3 may now be stored in RAM 207 and, in step 501, the probe 141 is raised.

In step 265, the pen 25 is moved to the top of the paper 33. This may be easily performed since the positions of the right and leading edges of the paper 33 are known. In step 267, the desired plotting on the paper 33 is performed in any of a number of well-known ways as is typified, e.g., by the procedures used by the Hewlett-Packard Co. model 7580B plotter.

In step 269, the sheet of paper 33 may be ejected from the plotter 1 into the receiving tray 7 after plotting has been completed. FIG. 17 shows the step 269 in greater detail. In step 521, carriage 27 is raised to ensure that probe 141 and pen 25 do not contact the paper 33. In steps 523–527, the grit wheels 81, 83 are rotated a sufficient number of times to ensure that the paper 33 is fully ejected from the grit wheels 81, 83 and that a sufficient acceleration is imparted thereto to ensure that the paper 33 enters the tray 7.

Finally, another pre-feed step 255 may be performed for the next plot if so desired.

We claim:

1. A plotter for writing on a sheet of recording medium, comprising:

a surface for supporting the sheet in an X-Y plane;

carriage means, above the surface and movable in the Y-axis, for carrying a pen;

an alignment edge, parallel to the X-axis and located at an edge of the surface for contacting an edge of the sheet;

first drive means, located within the surface and in proximity to the alignment edge, for selectably gripping the sheet and imparting to the sheet a single force substantially parallel to the X-axis and thereby urging the sheet along the X-axis in a forward or reverse direction;

second drive means, located within the surface and distant from the alignment edge, for selectably gripping the sheet in conjunction with the first drive means and imparting to the sheet a single force substantially parallel to the X-axis and thereby urging the sheet along the X-axis in a forward or reverse direction; and

lifting means, coupled to the first and second drive means, for causing the first drive means to grip the sheet either alone or in conjunction with the second drive means;

such that the sheet moves substantially parallel to the X-axis when both the first and second drive means grip and urge the sheet and such that the sheet moves substantially parallel to the X-axis and also tends to rotate about the first drive means and to align against the alignment edge when the first drive means grips and urges the sheet and the second drive means is disengaged from the sheet.

2. A plotter for writing on a sheet of recording medium, comprising:

a surface for supporting the sheet in an X-Y plane;

carriage means, above the surface and movable in the Y-axis, for carrying a pen;

an alignment edge, parallel to the X-axis and located at an edge of the surface for contacting an edge of the sheet;

first drive means, located within the surface and in proximity to the alignment edge, for selectably gripping the sheet and urging the sheet along the X-axis in a forward or reverse direction;

second drive means, located within the surface and distant from the alignment edge, for selectably gripping the sheet and urging the sheet along the X-axis in a forward or reverse direction;

lifting means, coupled to the first and second drive means, for causing the first drive means to grip the sheet either alone or in conjunction with the second drive means;

detector means, attached to the surface, for detecting a leading or a trailing edge of the sheet; and

control means, coupled to the detector means, the lifting means and the first and second drive means, for causing the first drive means to grip the sheet alone and to urge the sheet along the X-axis in alternating forward and reverse directions such that the sheet pivots about the first drive means and the sheet edge is brought into alignment with the alignment edge.

3. A plotter as in claim **2**, wherein the first and second drive means each comprise a grit wheel and a pinch wheel.

4. A method for aligning a sheet of recording medium against an X-axis alignment edge, comprising the steps of:

feeding a leading edge of the sheet into first and second drivers, the first driver being proximate the alignment edge and the second driver being distant from the alignment edge;

gripping the sheet with both the first driver and the second driver;

urging the sheet in a forward X-direction with both drivers;

detecting a trailing edge of the sheet;

stopping the forward X-direction motion of the sheet;

releasing the sheet from the second driver; urging the sheet in a reverse X-direction with the first driver;

stopping the reverse X-direction motion before the sheet travels beyond the first driver;

urging the sheet in the forward X-direction with the first driver; and

stopping the forward X-direction motion before the sheet travels beyond the first driver;

whereby rotational forces about the first driver cause the sheet to align against the alignment edge.

5. A method as in claim **4**, wherein the last four steps of urging, stopping, urging and stopping are repeated in sequence a predetermined number of times.

6. A method as in claim **5**, further comprising:

returning the sheet to a predetermined starting position; and

gripping the sheet with both the first and second drivers.

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